PB87-188850

Superfund Record of Decision (EPA Region 2)
Brewster Well Field, Brewster
Putnam County, New York, September 1986

(U.S.) Environmental Protection Agency
Washington, DC

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16. ABSTRACT

The Brewster Well Field, located on the northern bank of the East Branch Croton River, is three-quarters of a mile east of the Village of Brewster, Town of Southeast, Putnam County, NY. The land to the north and west, containing the community of Brewster Hill and the Village of Brewster respectively, is largely residential, while most of the land south of the site area is occupied by commercial or light industrial facilities. Since 1954 when Well Field No. 1 was developed, the Village of Brewster has used the aquifers beneath the Village-owned land as a water supply source. In 1967 Well Field No. 2 was brought on line. The two well fields consist of a total of 18 shallow wells. In 1978 evidence of volatile halogenated organic compound contamination from an unidentified source first appeared. Five alternative water sources were subsequently added to the water supply system. Prior to drought conditions arising in 1981, East Branch Croton River surface water was also used at times to supplement the water supply system. Since 1979, the Village of Brewster has conducted studies to identify potential alternative ground water sources and to test spray aeration as a potential treatment method for VHO removal. In 1984 under a Cooperative Agreement with the EPA Office of Research and Development, the Village installed a fullscale packed column for treatment of the entire Village supply. It has been concluded that treatment of existing sources is the most promising of the alternatives for solving existing contamination
(See attached sheet)

17. KEY WORDS AND DOCUMENT ANALYSIS

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Superfund Record of Decision Brewster Well Field, NY Contaminated Media: gw, sw, soil Key contaminants: VOCs, TCE, PCE, DCE		

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September 1986

EPA

Superfund Record of Decision:

BREWSTER WELL FIELD,NY

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16. ABSTRACT (continued)

problems, and based on trends, it is believed that the Well Field has reached a steady state condition, whereby contaminant levels are not expected to increase at the Well Field in the future. VHOs have been the primary contaminants detected in the ground water. The principle contaminants were found to be tetrachloroethylene, trichloroethylene, and 1,2-dichloroethylene.

The selected remedial action includes: continued operation of the existing air stripper to treat the water supply; design and construction of a ground water management system which will include ground water extraction wells, air stripper treatment of extracted ground water and reinjection of treated water. Details of the ground water management system will be determined during design. The estimated capital cost for this remedial action is $163,912 with annual O&M of $27,468.

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION

SITE Brewster Well Field, Brewster, Putnam County, New York.

DOCUMENTS REVIEWED

I am basing my decision primarily on the following documents describing the analysis of cost effectiveness of remedial alternatives for this Site:

- Brewster Well Field Focused Feasibility Study
- Brewster Well Field Remedial Investigation
- Brewster Well Field Feasibility Study
- Staff Summaries and Recommendations
- Responsiveness Summary

DESCRIPTION OF SELECTED REMEDY

This Record of Decision calls for the following actions:

° Continued operation of the existing on-Site packed column air stripping system at the Well Field to provide to the Village a water supply that exceeds applicable or relevant and appropriate standards, thereby providing a very high level of public health protection; and

° Design and construction of a groundwater management system, consisting of extraction wells, treatment of the extracted water by an additional off-Site air stripper, and reinjection of the treated water, to contain the plume of contamination and restore groundwater quality south of the East Branch Croton River.

DECLARATIONS

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the National Contingency Plan (40 CFR Part 300), I have determined that the continued operation of the existing air stripping system treating the Village of Brewster's water supply and construction of a groundwater management system to contain the plume of contamination and restore groundwater quality south of the River, is a cost-effective remedy and provides adequate protection of public health, welfare and the environment. Furthermore, I have determined that it is necessary to undertake a supplemental Remedial Investigation and Feasibility Study to gather additional data and to evaluate the necessity to implement source control measures. A determination regarding future source control actions will be made upon completion of this work.

The State of New York has been consulted and agrees with the approved remedy. In addition, these actions will require future

operation, maintenance, and monitoring activities to ensure the continued effectiveness of the remedy. These activities at the proposed off-Site air stripper are presently considered eligible for Trust Fund monies for a period of one year, although pending CERCLA legislation may affect this eligibility and/or the period of eligibility. However, EPA will not participate in the cost of these activities at the existing on-Site air stripper. Said costs will continue to be paid by the Village of Brewster.

Funding of this remedial action will occur at the time of CERCLA reauthorization; moreover, I have determined that the action being taken will be appropriate when balanced against the future availability of Trust Fund monies for use at other activities.

September 30, 1986
Date

Christopher J. Daggett
Regional Administrator

SUMMARY OF
REMEDIAL ALTERNATIVE SELECTION
BREWSTER WELL FIELD

SITE LOCATION AND DESCRIPTION

The Brewster Well Field is located on the northern bank of the East Branch Croton River, 3/4 of a mile east of the Village of Brewster, Town of Southeast in Putnam County, New York. The Site is approximately 3 miles west of the Connecticut/New York border and approximately 47 miles north of New York City. Interstate 84 passes just to the west of the Site (see Figure 1).

The land to the north of the study area, containing the community of Brewster Hill, is largely residential with some agricultural use. Most of the land south of the study area is occupied by commercial or light industrial facilities. To the west is the residential community of the Village of Brewster.

The 1980 Census records the population of Putnam County as 77,193. Projected 1980 figures for the Town of Southeast and the Village of Brewster are 15,500 and 1,700 respectively. The municipal water system serves the Village and several areas in the Town of Southeast, a number of business establishments and the Consolidated Rail Corporation's Putnam Junction Rail Yard. Residential users alone count for an estimated 2,100 people.

Additional potential receptors are downstream users of the East Branch Croton River which contributes to the Croton Falls Reservoir approximately 3.5 miles downstream. The East Branch Croton River flows adjacent to and south of the Well Field. Three thousand feet to the east of the Site (upstream) the River is impounded to form the East Branch Reservoir, part of New York City's Croton watershed reservoir system. Three thousand feet from the Site to the northeast, Bog Brook, a tributary to the East Branch Croton River, is impounded to form Bog Brook Reservoir, also owned by New York City as shown on Figure 2.

The subsurface geology of the area is highly varied giving rise to an extremely complex subsurface hydrology. Groundwater throughout the area may be found in both the bedrock and unconsolidated sediments. In bedrock, the water primarily occurs in joints and fractures. In the unconsolidated deposits water exists in the pore spaces. Permeability varies over many orders of magnitude. The bedrock and unconsolidated aquifers may act as distinct aquifers, or as one, depending on the degree of hydraulic connection between the two. Both situations occur in the vicinity of the Brewster Well Field.

SITE HISTORY

Beginning in 1954, when Well Field No. 1 was developed, the Village of Brewster has used the aquifers beneath the Village-owned land, in the Town of Southeast, as a source of water for its water supply system. In 1967 Well Field No. 2 was brought on-line. The two well fields consist of a total of 18 shallow wells. Evidence of volatile halogenated organic compound (VHO) contamination first appeared in 1978, and alternative water sources were subsequently added to the water supply system, including a deep bedrock well (DW-2) and two separate shallow wells (SG-1 and SG-2) located as shown on Figure 3. As a result of low yield DW-1 was not connected to the supply system. Two new wells SG-3 and SG-4 were added to the system in 1984. Prior to drought conditions arising in 1981, East Branch Croton River surface water was also used at times to supplement the water supply system.

Since 1979, the Village has had several studies conducted to identify potential alternative groundwater sources and to test spray aeration as a potential treatment method for VHO removal. It has since been concluded that treatment of existing sources is the most promising of the alternatives for solving existing contamination problems in the Well Field. Under a cooperative agreement with the EPA, Office of Research and Development, the Village has constructed, tested and in 1984, placed on line, a full scale packed column for treatment of the entire Village supply.

In 1985, a study (Focused Feasibility Study) was conducted by NYSDEC, to investigate the feasibility of on-Site treatment alternatives for removal of volatile halogenated organic compounds from the Village's water supply. Considering cost, reliability, off-Site releases and flexibility, the packed column was adjudged superior to other alternatives.

CURRENT SITE STATUS

Concurrent with the Focused Feasibility Study a Remedial Investigation (RI) was initiated by NYSDEC to determine the nature and extent of contamination at and in the vicinity of the Site.

Volatile halogenated organic compounds have been the primary contaminants detected in the groundwater from the Well Field and in the vicinity of the Site. Groundwater samples taken during the RI were analyzed for a wide variety of organic volatiles and samples from wells DGC-6, DGC-14 and the raw water influent to the air stripper were subjected to full Hazardous Substance List (HSL) analysis. The principle contaminants were found to be tetrachloroethylene (PCE), trichloroethylene (TCE) and 1,2 dichloroethylene (DCE).

Groundwater sampling and monitoring has been ongoing at the Site since 1978 when VHO contamination was first discovered. Table 1 lists the full range of contaminants and their maximum reported concentrations discovered at the Site based on RI findings, NYSDOH studies and other reports.

Table 2 summarizes the RI analytical data for the most prevalent contaminants (PCE, TCE, and DCE) by media sampled.

PCE, TCE and DCE are suspected carcinogens and known causes of liver and kidney damage and central nervous system depression in humans. Toxicity profiles for each of these principal contaminants are provided in Appendix A.

Based on the results of the extensive field reconnaissance, sampling and analysis of data collected during the RI, the extent of the contamination at the Brewster Well Field can be approximated. Figure 4 is a schematic of the contamination found at and in the vicinity of the Well Field in terms of total VHO. The highest levels of contamination encountered in this area were in groundwater sampled from RI monitoring well cluster DGC-6, in the intermediate well screened at a depth of 29.7 to 32.2 feet. As evidenced in Figure 4, other elevated levels of VHOs were also encountered in the Well Field and in areas south of the East Branch Croton River. The highest levels are theorized to occur in a relatively narrow band south of the River, with lower concentrations extending to the north.

The contours shown on Figure 4 were developed based on the October 1985 field sampling analysis and hydrogeologic information described in the RI. The shape of the plume theorized and represented on Figure 4 was developed incorporating the results of groundwater analyses and considering groundwater flow conditions in the Well Field vicinity while the production wells were extracting water for service to the Village system. The asymetrical shape of the isoconcentration lines depicts the influence of both groundwater flow and production well pumping. This configuration tends to support the premise that contaminants were discharged southeast of DGC-6 and have moved as a "slug" to their present position under the influence of natural and Well Field-induced groundwater flow. The isoconcentration lines in the vicinity of the Alben Cleaners premises (a suspected source) are subject to verification because borings were not executed on that property.

Results of groundwater sample analyses from intermediate wells at RI well clusters DGC-1 (screened at 35.7 to 40.7 feet) and DGC-12 (screened at 35 to 40 feet) indicate low levels of VHO. The presence of these contaminants at the locations shown on Figure 4 is not fully explained by hydrogeologic conditions and pumping. Since the concentrations are low, the observed contamination may simply indicate dispersion of the plume. In regard to the contamination indicated in the vicinity of SG-3 & 4 and SG-1 &2

(see Figure 4) it is probable that contamination initially drawn to Well Field No. 1 was drawn directly to the east at the 25-40 feet depth by subsequent pumping in Well Field No. 2, SG-3 & 4 and SG-1 & 2. Apparently through continual pumping by wells SG-1 & 2 and SG-3 & 4, contamination has also been moving from the DGC-6 area directly northeast toward these pumping wells but at significantly increased depths. Evidence of this is the concentration and depth of contamination observed in the intermediate well at DGC-8.

Deep well samples of wells installed during the RI in bedrock showed no contamination at and in the vicinity of the Well Field. Based on RI findings groundwater flow is expected to be from the bedrock to the overlying unconsolidated aquifer under non-pumping conditions. Under pumping conditions from wells in bedrock (i.e., DW-2) hydraulic head is reduced locally and flow from the unconsolidated contaminated aquifer may be induced into the bedrock. This would account for contamination detected in DW-2 which is in close proximity to Well Field No. 1.

Sampling and analysis conducted during the RI, in addition to groundwater, included water in drainlines in the vicinity of the Site, surface water, private water wells, soil and air.

Discharges from a culvert northeast of Alben Cleaners revealed average levels of PCE at 88 ug/l, TCE at 14 ug/l and DCE at 6 ug/l based on 134 samples taken. Surface water samples taken at various locations in the vicinity of the Well Field show isolated incidents of trace amounts (less than 5 ug/l) of VHO. In the East Branch Croton River a maximum of 5.4 ug/l of total VHO was encountered in the vicinity of the Alben Cleaners culvert outfall.

Surveys (including drainline inventories and sampling) of two other business establishments in the immediate study area, Brady Stannard's and Savino's garages, indicate that neither are likely sources of contaminant discharges of the type encountered in groundwater south of the River.

Further downstream toward the I-84 overpass and beyond I-84 samples from the River showed trace amounts (2 to 4 ug/l) of PCE. While these concentrations are low they demonstrate the potential for an interchange of contaminated groundwater with the River. Based on the RI results, however there is no significant surface water contamination at and in the vicinity of the Site except for the culvert discharge northeast of Alben Cleaners.

Based on 65 private wells water samples high concentrations of PCE (64 ug/l) were found in the vicinity of the Henry Van Motel, east and upgradient of the Site. Trace amounts (less than 5 ug/l) of VHO were also found at the Harley Davidson Shop east of the Site. However, it is not likely that these levels of contamination are associated with the Well Field contamination, since a downgradient monitoring well was found to be clean during the investigation. Monitoring of these facilities was recommended in the RI.

During the installation of the RI monitoring well clusters, soil samples were screened to determine concentrations of PCE, TCE and DCE at varying depths using a semi-quantitative analysis method on an HNu 301 portable gas chromatograph. A total of 326 soil samples were screened as part of the RI field program. Various degrees of contamination were found in well locations DGC-1, -3, -6, -7, -8, -9, -12, -13, -14, -15, -16, -17, and -19. Highest levels of VHO contamination in the soil were found in boring locations DGC-6 (247 ppb), DGC-7 (71 ppb), DGC-9 (172 ppb), DGC-17 (44 ppb) and DGC-19 (290 ppb) (see Table 3). These locations coincide with the maximum groundwater contamination levels found during the RI.

An ambient air monitoring survey was conducted around the Site vicinity during the RI. Volatiles were not detected in any of the locations.

Based on hydrogeologic findings (groundwater modeling) and analytical data for groundwater samples in the vicinity of the Site, highly contaminated groundwater south of the River is in hydraulic connection with waters being withdrawn from the Well Field for Village use. Contaminant levels in the Village wells have never shown total VHOs as high as 5,000 ug/l as discovered in monitoring Well DGC-6. Groundwater modeling shows that this is due to infiltration from the River and the infiltration channel near Well Field No. 1 diluting contamination in waters withdrawn in the production wells. Dispersion caused by pumping from widely scattered well locations and comingling with uncontaminated water from other areas of the aquifer also dilute groundwater withdrawn from the Well Field.

Based on trends, it is believed that the Well Field has reached a steady state condition, whereby contaminant levels are not expected to increase at the Well Field in the future.

ENFORCEMENT

No negotiations with potentially responsible parties have been conducted up to the present time. Lack of an obvious source of contamination has deterred enforcement efforts. The RI/FS has succeeded in suggesting Alben Dry Cleaners as a probable source. Enforcement activity will commence, concurrent with the development of the supplemental RI/FS, to further investigate this probability. The supplemental RI/FS, recommended in this Record of Decision, will further investigate suspected source areas and will be designed to facilitate this enforcement effort.

ALTERNATIVES EVALUATION

The public health and environmental objectives of the RI/FS were as follows:

- °Provide a safe, reliable water supply, meeting EPA standards, to the Village of Brewster;
- °Contain the plume of contamination to mitigate further contamination of public water supplies;
- °Restore groundwater quality at and in the vicinity of the Brewster Well Field to acceptable levels (NYS groundwater standards).

The objective of the proposed supplemental source control RI/FS will be to determine which, if any, additional source control measures are necessary, feasible and cost effective.

Initial Screening Of Alternatives

Remedial action objectives established for the FS include both system objectives (water supply treatment) and source control objectives (plume containment). The system objectives focus on control of the quality of the water delivered to the users of the Brewster supply system. The source control objectives address means of containment of contamination identified in the plume area south of the East Branch Croton River and aquifer restoration. Accordingly, a full range of more than 110 alternative technologies, and variation of technologies, for treatment and source control were initially screened to determine potential applicability and appropriateness to the particular problems existing in the Brewster Well Field and its vicinity.

These technologies were then evaluated based on existing site conditions, including contaminant distribution, geological and hydrological conditions, technical merit and reliability, potential effectiveness in meeting remedial objectives, and costs, in order to establish a final list of candidate technologies to be considered in formulating remedial action alternatives. See Table 4.

The technology screening process resulted in a reduced list of technologies judged to be suitable for inclusion, singly or in combination, as components of remedial action alternatives. See Table 5.

These selected technologies were then combined to formulate potential alternative actions that address site problems (i.e., groundwater contamination) existing at the Well Field and off-Site south of the River. This effort resulted in formulation of eleven potential remedial action alternatives by considering technologies which address remedial action objectives for both system control and source control.

Of the eleven alternatives five were eliminated. The individual treatment systems alternative was dropped from consideration due to uncertainties regarding operation and maintenance (O&M) and high capital and O&M costs.

Alternative water supplies were eliminated as an option based on institutional constraints (e.g., constraints on water quantity supplied by another municipality), potential problems during drought conditions, and high costs.

Groundwater collection, treatment and discharge to the River was dropped from consideration because other alternatives provide the same benefits of extraction and treatment with the added benefit of employing an innovative groundwater management technique which would control the contamination source by recharge of treated water to the plume area. Additionally, this alternative could possibly introduce contaminated water to the River.

Groundwater collection, treatment and recharge to the Well Field was also eliminated from further consideration due to higher capital and O&M costs and because it lacks the benefit of groundwater management to control the contamination source by recharge to the plume area.

Soil aeration was eliminated due to the length of time required to achieve remediation as compared to soil excavation and removal.

In formulating the final alternatives for evaluation it was recognized that none of the source control alternatives would be effective in meeting the water quality objectives required in the Village water supply system without also incorporating treatment in the packed column. Accordingly, the existing packed column air stripper was included in each of the remedial action alternative scenarios chosen for detailed evaluation. The final listing of alternatives evaluated in detail is therefore:

Alternative I - No action

Alternative II - Operation of the existing packed column air stripper

Alternative III - Existing air stripper, groundwater collection, treatment and injection east of plume

Alternative IV - Existing air stripper, groundwater collection, treatment and injection west of plume

Alternative V - Existing air stripper, groundwater collection, treatment and discharge to the existing air stripper at the Well Field

Alternative VI - Soil handling alternatives

A detailed analysis of these alternatives was then performed, consistent with 40 CFR Part 300.68(i). The detailed analysis of each alternative included refinement and specification of alternatives in detail, with recognition of the reliability of the use of established technology; detailed cost estimation, including operation and maintenance cost, and distribution of costs over time; evaluation constructability; assessment of the extent to which the alternative is expected to effectively prevent, mitigate, or minimize threats to, and provide adequate protection of public health; and an analysis of any adverse environmental impacts.

Applicable or relevant and appropriate standards for this Site include EPA's Maximum Contaminant Levels (MCLs), which have been proposed pursuant to the Safe Drinking Water Act, and New York State's groundwater quality standards established pursuant to the Clean Water Act. The applicable proposed MCL for trichloroethylene is 5 ug/l; the applicable State groundwater standard for trichloroethylene is 10 ug/l.

Contaminant	Applicable Standard	Concentration Limit
TCE	EPA Safe Drinking Water Act	5 ug/l
TCE	NYS Groundwater Standards	10 ug/l

An evaluation of alternatives (which is summarized in Table 6) follows. Complete costs associated with these alternatives are presented in Appendix B.

Alternative I - No Action

For the Brewster Well Field evaluation, the no action alternative depicted conditions that would exist in the Well Field and municipal water supply system without the presence of the packed column air stripper constructed in 1984. Conditions that would exist without existing treatment then formed a baseline against which the other alternatives were compared. The no action alternative does assume, however, that actions taken by the community following the discovery of contamination in 1978, such as Well Field management to blend waters to control contamination and construction of the new wells on-Site, have been implemented.

The no action alternative is completely unacceptable in its ability to provide a drinking water supply in the near future meeting EPA MCLs for trichloroethylene. Based on models and simulations, normal pumping of the Well Field would not result in contaminant reduction in the Well Field to 5ppb levels (assuming no new source) for about 25 years; and groundwater south of the River would be contaminated at levels in excess of 5ppb for 30-35 years.

Alternative II - Operation of Existing Packed Column Air Stripper

This alternative consists of the continued operation of the on-Site packed tower air stripper. The packed tower has been designated by EPA as a Best Technology Generally Available (BTGA) for volatile organic comounds (VOC) removal from drinking water (40 CFR 141 and 142) and has been extensively tested and proven at the Brewster Site. Removals of contaminants have been reported at 99% or more and levels meeting EPA MCLs have reliably been met. Therefore, this alternative will exceed applicable or appropriate and relevant standards, providing a very high level of public health protection with respect to the Village's water supply. This alternative does not include source control measures.

Times to restore groundwater quality at the Well Field and area south of the River would be the same as Alternative I.

Gaseous emissions from the air stripper consist of extremely low levels of volatiles which will pose no chronic or subchronic health threats to downwind receptors (e.g., worst case PCE concentrations at the top of the stripper are estimated at 1.6 ppm versus 8 hour Threshold Limit Values of 50ppm recommended by the American Conference of Governmental Industrial Hygenists).

Alternative III - Existing Air Stripper, Groundwater Collection, Treatment and Injection East of Plume

This alternative assumes that Alternative II (treatment of the existing public water supply by an on-Site packed column stripper) would be implemented and, additionally, assumes that remedial facilities would be constructed in the area south of the River. These facilities would include extraction wells, an additional packed column stripper to treat extracted water (to 99.9% removal of VOCs) and passive injection wells east of the plume area. See Figure 5.

Groundwater modeling of the collection/treatment/recharge system indicate that the quantity of water from the producing wells at the Well Field would not significantly be affected. Simulations also predict that contaminant levels of 5ppb or less could be achieved at the Well Field and in groundwater south of the River in about 10 years with collection/treatment/recharge.

Alternative III, therefore, presents a solution to the source contamination problem by meeting the objectives of plume containment and restoration of aquifer quality as well as reducing long term public health and environmental risks by remediating the contaminated public water supply.

Extraction and injection wells and the air stripper could be installed with no adverse impacts on New York State regulated wetlands and with minor impact to areas classified as wetlands under Federal regulations. No significant adverse air quality

impacts would be expected from the air stripping process. The passive injection wells would require approval from the EPA as Class V wells under Underground Injection Control regulations pursuant to the Federal Safe Drinking Water Act.

Since much of the work contemplated south of the River is on lands under control of the City of New York, City approval would also be required. The benefit of cleanup would accrue to the City as well as the Village and, as a result, approval would be anticipated.

Alternative IV - Existing Air Stripper, Groundwater Collection, Treatment and Injection West of Plume

This alternative consists of the same technology components identified in Alternative III. The difference between the alternatives involves the location of the injection wells. In Alternative IV extraction wells would be placed on the eastern side of the plume area, with injection wells to the west. As in the case of Alternative III an on-Site air stripper, to treat the Village water supply, is also assumed. See Figure 6.

This scenario was identified during analytical modeling as potentially the most effective. Flushing of water across the most contaminated areas is enabled and a hydrodynamic barrier is placed down-valley from the plume. However, without 100 percent treatment efficiency (estimated at 99.9%) some injected water with low-level (5.6 ppb) VHO contamination would probably flow downgradient and some of the water injected on the west side of the plume area may be lost downgradient to the west, out of the vicinity of the influence of the Well Field production wells. Further, the precise location of the western boundary of the plume is not yet known, making monitoring of this alternative difficult.

Otherwise this alternative is similar and judged equal to Alternative III. Groundwater restoration times would be equal to Alternative III (10 years).

Alternative V - Existing Air Stripper, Groundwater Collection, Treatment and Discharge to Existing Air Stripper at the Well Field

Alternative V includes an on-Site packed column air stripper, the same as Alternatives II, III and IV. Similar to Alternatives III and IV, extraction and treatment, in an off-Site stripper, of water from the contaminated plume area south of the River is also assumed. Under this alternative, however, no injection well would be used. Instead, the treated effluent from the off-Site stripping column would be piped to the on-Site treatment system for further treatment along with water from the Well Field production wells. See Figure 7.

The performance of the on-Site stripper, in removal of VHOs from the public water supply, would be excellent as long as the effluent from the off-Site stripper contains VHO levels equal to or less than levels encountered in water from the production wells. Accordingly, State standards and proposed Federal MCLs should be met. In regard to source control objectives, the extraction and treatment of groundwater from the source area south of the River would contribute both to containment and restoration objectives. Projected benefits to groundwater quality are similar to Alternatives III and IV. However, extraction without reinjection in the area south of the River may result in a slightly longer period for restoration of groundwater quality, when compared to Alternatives III and IV.

In order to ensure that the off-Site stripping system is working properly to produce an effluent amenable to mixing with waters from the projection wells extra precautions would be necessary. At the off-Site stripper this would be provided by additional controls and more frequent maintenance and monitoring. These additions are reflected in additional costs.

Risks exist in this alternative of possibly inducing a new class of pollutants into the source of Brewster water supply. For example, if yet undetected non-volatile contaminants exist in the groundwater south of the River they could be drawn into the system and not removed by the air strippers, because air stripping is effective only on volatile compounds. At a minimum, full monitoring for all Hazardous Substances List (HSL) compounds would be required on a periodic basis to avoid this possibility.

This alternative would require a pipeline crossing under the River (with probable adverse environmental impact) and a physical hookup to the raw water feed line of the on-Site stripper. In addition, certain institutional approvals would be required from the State, the City of New York and the Village of Brewster.

The complexities involved in implementation of this alternative makes it less attractive than other alternatives.

Alternative VI - Soil Handling

Soil contamination alternatives are addressed separately because these actions may be implemented as part of any remedial action plan. The objectives of the soil contamination alternatives are to identify zones of soil contamination or residues that may be contributing to groundwater contamination and identify the means to eliminate such sources, if feasible.

Meeting these objectives would require two steps: first, identification of soil contamination areas; and second, remediation.

The most likely source of VHO contamination identified during the RI is the premises of Alben Cleaners. However, no confirmation of the existence of localized contamination in the Alben Cleaners area was provided during the RI studies. In order to identify whether a continued source of contamination exists on those premises a program of test pitting, shallow well installation and contaminant analysis would be undertaken.

If soil contamination is encountered in significant levels, a program to excavate the soils in the unsaturated zone would be carried out. For purposes of estimates it was assumed that an area about 43 feet wide by 80 feet long by 6 feet deep would require excavation east of the Alben Cleaners building. Several options exist for soils handling under these conditions, depending on contamination levels encountered. For example, soils could be loaded and transported off-Site to a secure (RCRA approved) landfill. Soils could also be treated on-Site using rotary kiln or infrared incineration. Data from the supplemental RI/FS will assist in further evaluating this alternative.

Any of several innovative soil remediation measures could be effective in achieving the stated objectives depending upon the type and quantity of contaminants present. Off-Site disposal could be accomplished relatively easily, while on-Site soil remediation would be more difficult to implement. All alternatives could be carried out in accordance with environmental regulations.

RECOMMENDED ALTERNATIVE

The appropriate extent of remedy shall be determined by EPA's selection of a cost-effective remedial alternative that effectively mitigates and minimizes threats to and provides adequate protection of public health and welfare and the environment. This will normally require selection of a remedy that attains or exceeds applicable or relevant and appropriate Federal and State public health and environmental requirements that have been identified for the Site.

Discounting the no action alternative (since the packed tower air stripper is already in place), each of the alternatives selected for detailed evaluation would provide an appropriate extent of remedy within the above definition. Based on meetings with New York State, its consultants, the Village of Brewster and the public, it is recommended that continued operation of the existing air stripper to treat the Village's water supply and design and construction of a groundwater management system to contain the plume of contamination and restore groundwater quality south of the River, be selected as the remedy for this project. The groundwater management system will include groundwater extraction wells, air stripper treatment of extracted groundwater and reinjection of treated water. Details of the groundwater management system will be determined during design.

This alternative provides a safe and reliable water supply to the Village that exceeds applicable or relevant and appropriate standards, thereby providing a very high level of public health protection. This alternative will also restore groundwater quality south of the River to levels exceeding applicable State groundwater standards.

Detailed cost estimates for the recommended alternative are included in Apendix C.

COMMUNITY RELATIONS

Community perception of the Brewster contamination problem has been an important factor in placing this site on the Superfund National Priorities List. VHOs were discovered in the Village's water supply in 1978. Considerable local press regarding the issue contributed to public awareness.

Since the NPL listing in December 1982, public concern has subsided, and the townspeople have been generally satisfied that appropriate action is being taken and that no contaminated water is being consumed. However, there is still concern regarding the potential spread of contamination.

Specific concerns that were raised during the public comment period are answered in the Responsiveness Summary. All comments were made at the public meeting held on August 21, 1986 at the Brewster Village Hall. No other comments, writtten or otherwise, were received during the public comment period.

CONSISTENCY WITH OTHER ENVIRONMENTAL LAWS

At the present time, there are no Federal environmental laws other than the Safe Drinking Water Act which are applicable to implementing the selected remedial action at this Site.

Trichloroethylene has been chosen by EPA for evaluation and possible future regulation pursuant to the Clean Air Act's National Emission Standards for Hazardous Air Pollutants (NESHAP). However, such regulation will likely not be promulgated for 1-2 years. At the present time, EPA believes that the risk assessment performed for the operation of the packed column air stripper (using worst case assumptions throughout the analysis) has sufficiently demonstrated the extremely low risk associated with the predicted level of air emissions on likely receptor areas.

OPERATION AND MAINTENANCE

Packed column technology has been successfully applied for removal of VOCs at full scale water treatment plants in at least 24 locations in the United States. The equipment is commercially available; is relatively easy to operate; start-up and shut down can be

accomplished quickly; and the equipment can be designed to operate for a number of years. It has also been shown to operate under varying climatic conditions. The existing Brewster on-Site air stripper has successfully been operating for more than a year.

Costs estimates for the operation and maintenance of the on-Site (water supply) and off-Site (groundwater remediation) systems of the selected remedy are included in Appendix C. EPA will not participate in the cost of operating and maintaining the existing on-Site air stripper. Said costs are to be borne by the Village.

FUTURE ACTIONS

A second operable unit consisting of additional source control remedial measures may be implemented following the supplemental RI/FS and issuance of a subsequent EPA Record of Decision.

FIGURES

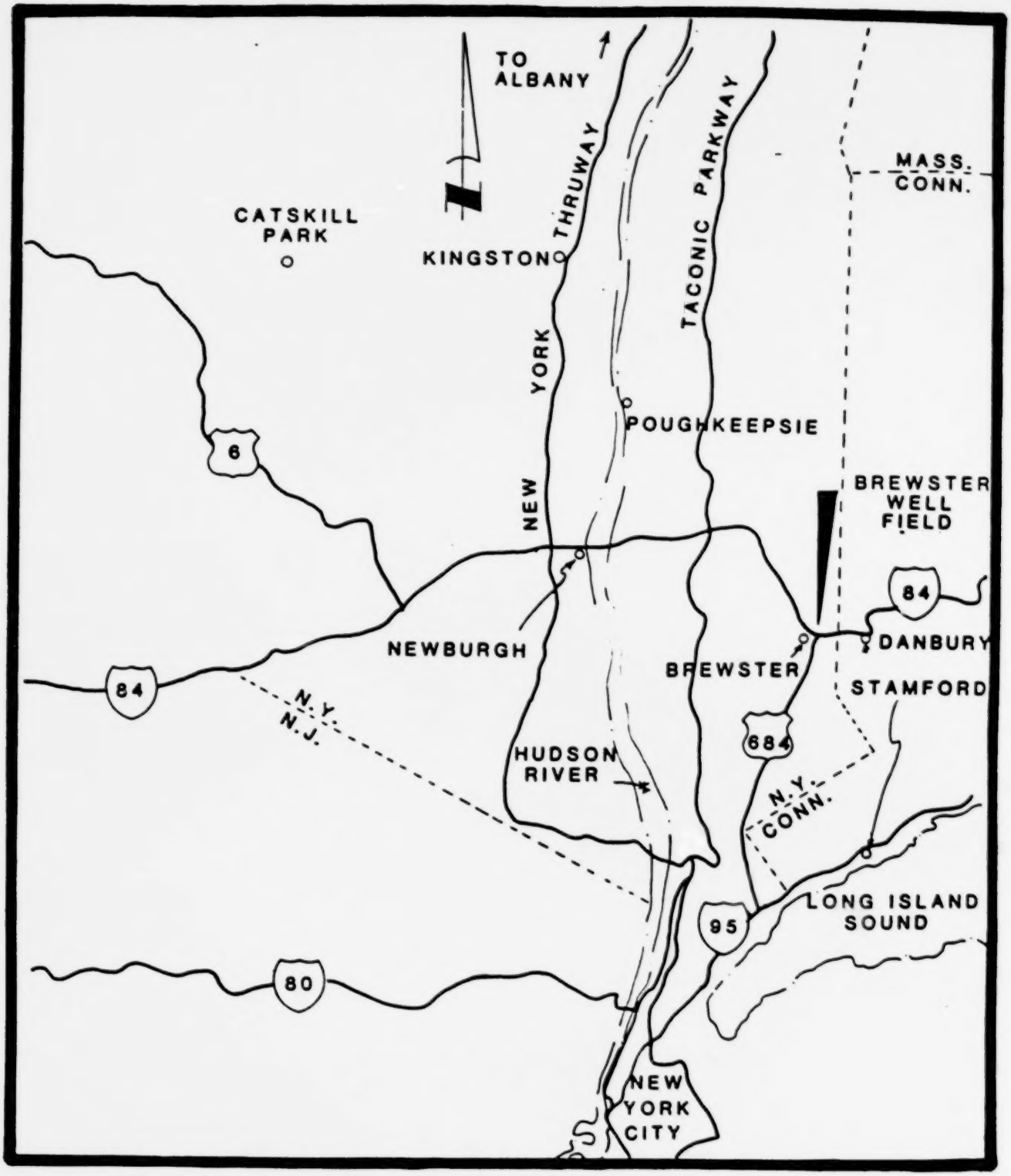
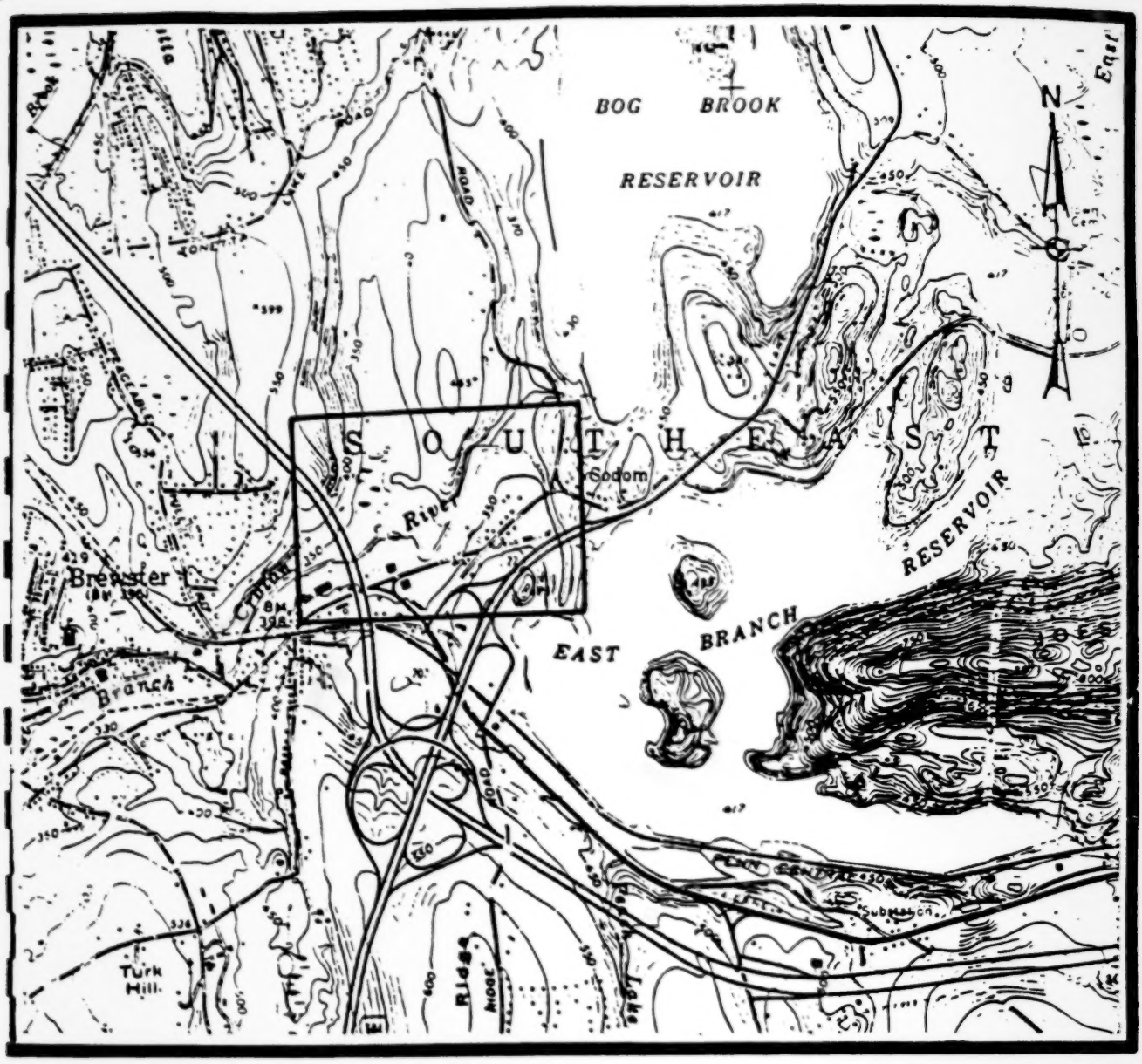


FIGURE 1

REGIONAL LOCATION

APPROXIMATE SCALE 1"-14 MILES



SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

BREWSTER, N. Y. – CONN.
N4122.5--W7330/7.5

1958
PHOTOREVISED 1970
AMS 6266 I NE-SERIES V821

FIGURE 2
BREWSTER STUDY AREA LOCATION

QUADRANGLE LOCATION

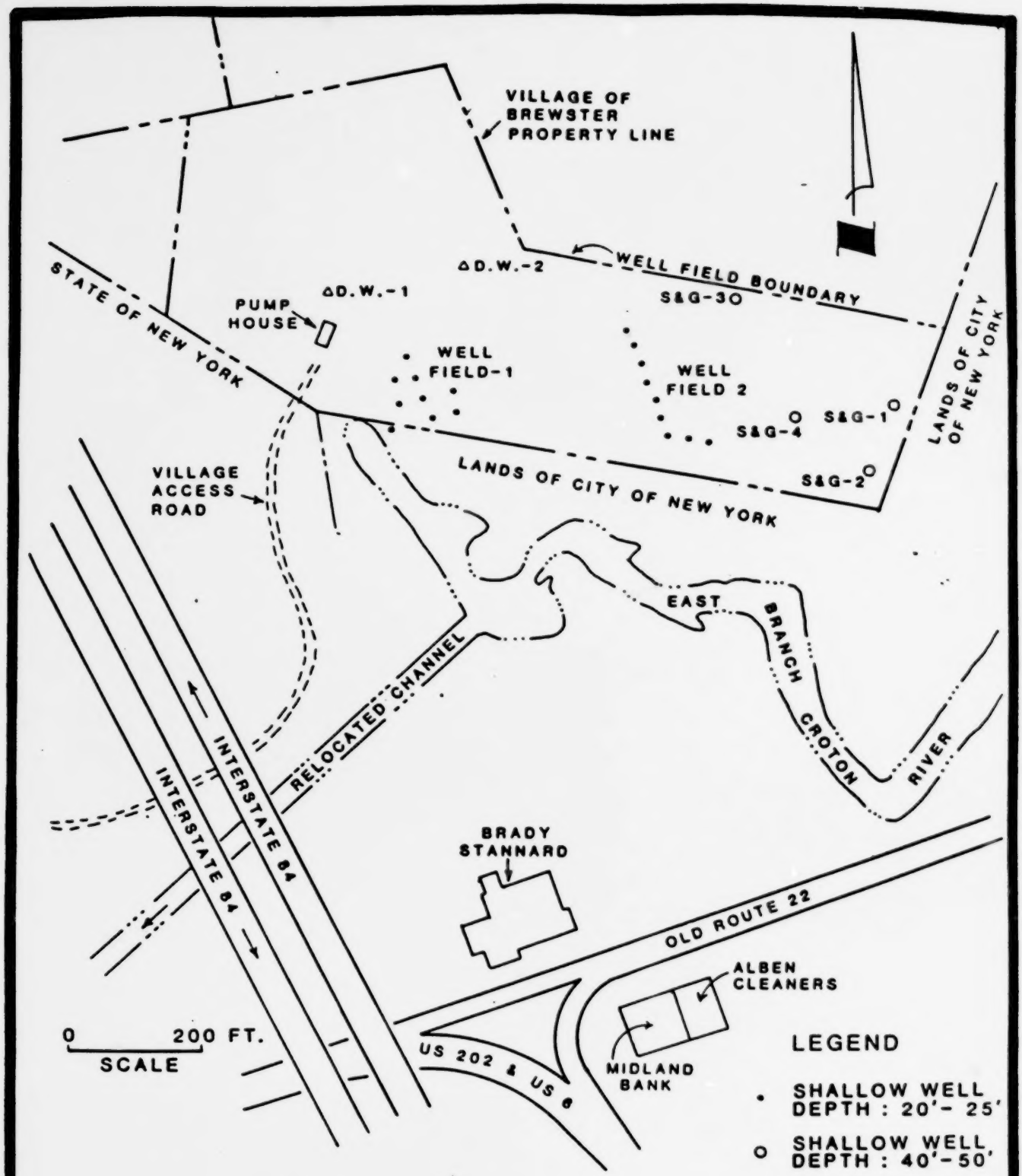


FIGURE 3

VILLAGE OF BREWSTER, N.Y.
WELL FIELD AND VICINITY LOCATION MAP

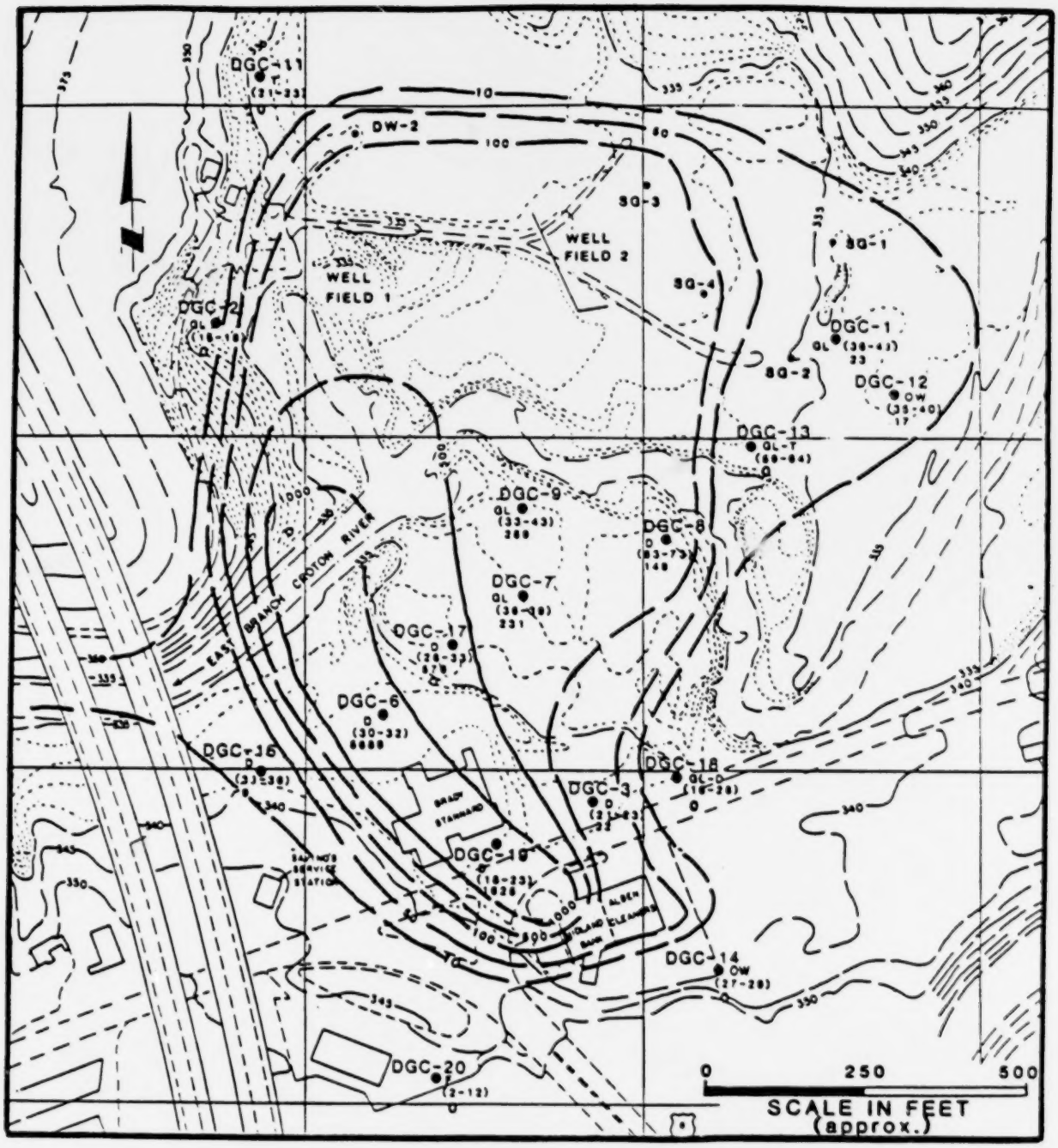


FIGURE 4

ISOCONCENTRATION MAP, TOTAL CONCENTRATION OF
VHO AT MONITORING WELL LOCATIONS
BASED ON SAMPLE ROUND NO. 1 (OCTOBER, 1985)

LEGEND

DGC-7 MONITORING WELLS

(10-20) SCREENED INTERVAL TO NEAREST FOOT

15 - TOTAL VHO

F - FILL
T - GLACIAL TILL
GL - GLACIOLACUSTRINE
D - GLACIOFLUVIAL-DELTAIC
OW - GLACIOFLUVIAL-OUTWASH
SG - SAND/GRAVEL SUPPLY WELL
DW- DEEP SUPPLY WELL

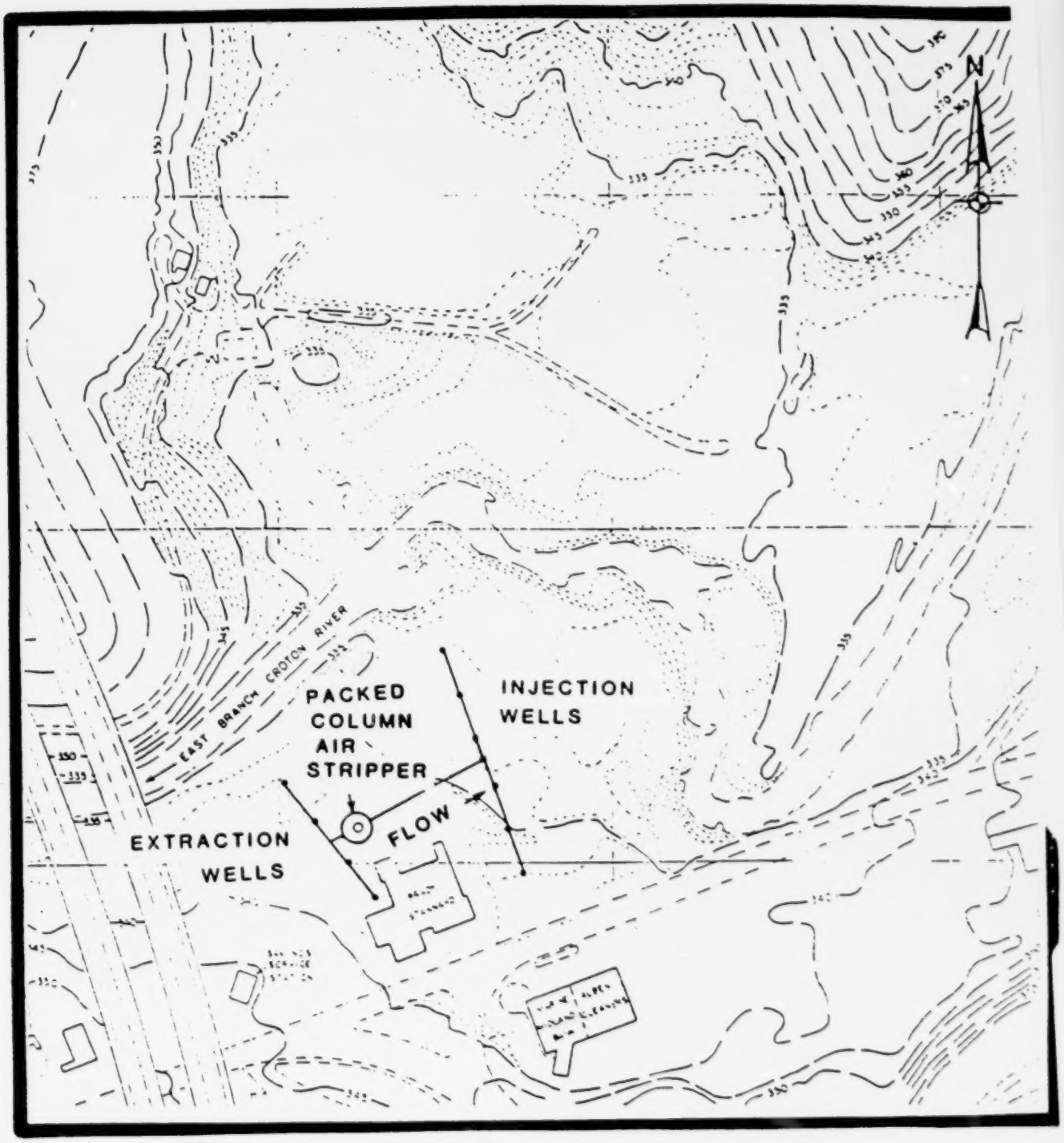


FIGURE 5

PRELIMINARY SCHEMATIC-ALTERNATIVE III

APPROX. SCALE 1":200'

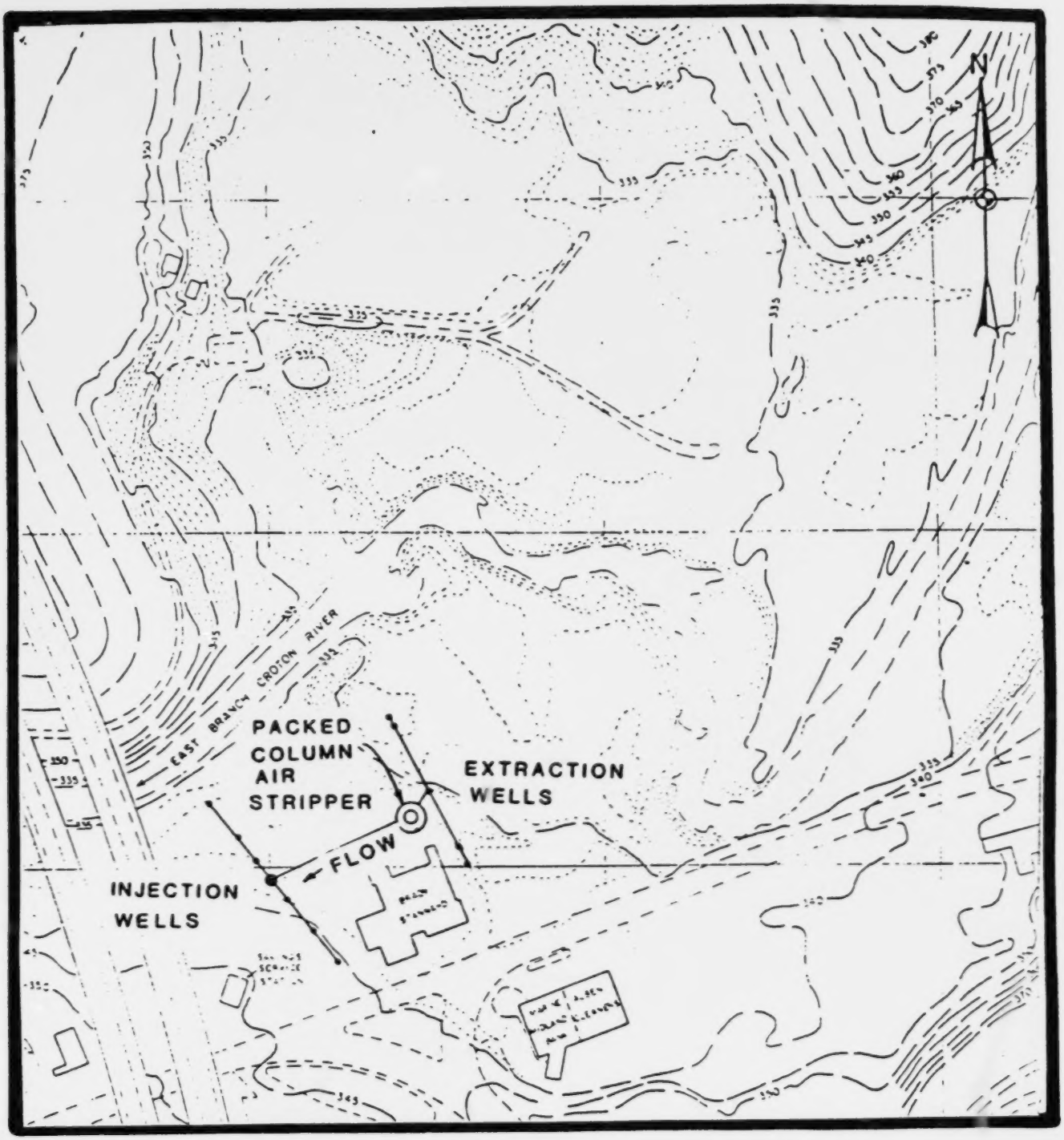


FIGURE 6

PRELIMINARY SCHEMATIC-ALTERNATIVE IV

APPROX. SCALE 1":200'

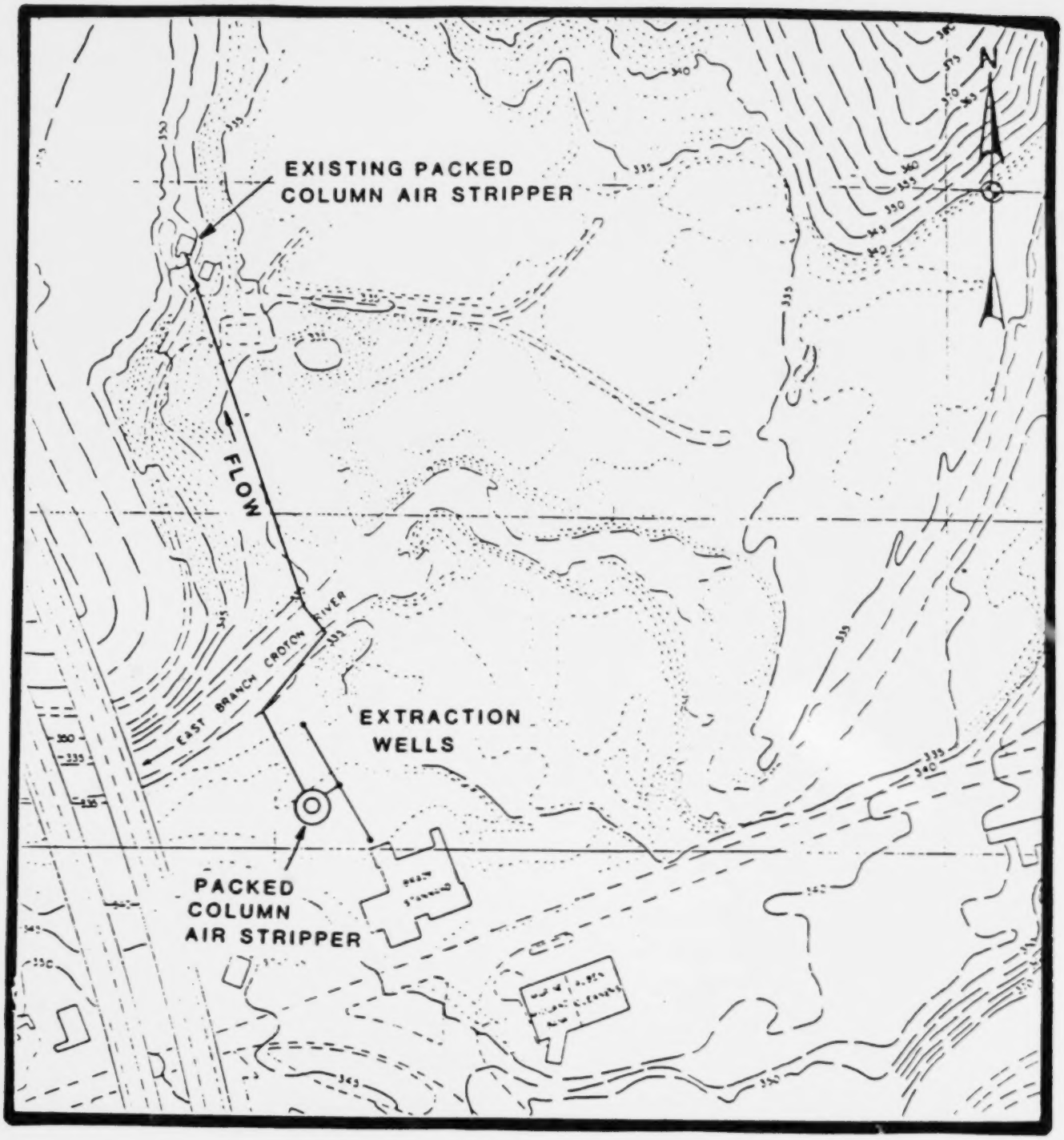


FIGURE 7

PRELIMINARY SCHEMATIC-ALTERNATIVE V

APPROX. SCALE 1" 200'

TABLES

TABLE 1

MAXIMUM REPORTED CONTAMINATION IN GROUNDWATER
RI AND PREVIOUS STUDIES (ug/l)

CONTAMINANT	MAXIMUM CONCENTRATION ug/l	OTHER RESULTS
Tetrachloroethylene	5600	5600 ug/l reported in Well 6I on 10/30/85 (CompuChem).* 12,500 ug/l reported in a sample taken from Well 6I on 4/15/86 (HNU 301 Screening). In a sample taken 10/8/85 from Well 6I, a concentration of 10,600 ug/l was reported (HNU 301 Screening).
Trichloroethylene	550	550 ug/l reported in a sample taken 12/27/79 from TH #12 (100 feet NE of the location of Well 6I) (H_2M)**. 120 ug/l reported in sample taken 10/22/85 from Well 6I (CompuChem). 224 ug/l was reported in a sample taken 10/8/85 from Well 6I (HNU 301 Screening).
cis-1,2-Dichloroethylene	950	950 ug/l reported in a sample taken from TH #12 on 12/27/79 (H_2M)**. In the distribution system, 22 ug/l was reported in a sample taken 4/14/81 (H_2M). In Well Field No. 1, 89 ug/l was reported in a sample taken 9/30/82 (H_2M).
trans-1,2-Dichloroethylene	210	210 ug/l was reported in a sample taken from Well 17I on 10/30/85 (CompuChem).
Carbon tetrachloride	---	A review of all available data from the RI and past reports showed no detectable levels of carbon tetrachloride. The RAMP Report (NUS, 1983) indicates a 5 ug/l concentration in the data, but the source of that data is unknown. It is presumed that reporting of the data should have included a "less than" sign in the RAMP compilation.
1,1,1-Trichloroethane	23	23 ug/l was reported in Deep Well No. 2 on 4/27/79 (O'Brien and Gere). 8 ug/l was reported in the distribution system on 12/13/78 and 7/16/80 (NYSDH). 450 ug/l was reported in a sample collected 10/5/78 at the Bottge septage disposal site. It is not known whether this was a groundwater sample or a grab sample taken at the surface (NYSDH?).
Chloroform	404	404 ug/l reported in a sample taken 10/5/78 from Well Field No. 1 (NYSDH) (Wells were being chlorinated at that time). 76 ug/l was reported in the distribution system 5/21/80 (NYSDH).

* CompuChem is CompuChem Laboratories; H_2M is H_2M Corporation Laboratories; NYSDH is New York State Department of Health Laboratories; HNU 301 Screening is Field GC Screening by GHR Engineering Associates using an HNU 301 GC.

** Putnam County Health Department notes that certain test holes sampled in 1979 may have been contaminated with pipe solvent.

TABLE 1 (continued)

MAXIMUM REPORTED CONTAMINATION IN GROUNDWATER
RI AND PREVIOUS STUDIES (ug/l)

CONTAMINANT	MAXIMUM CONCENTRATION ug/l	OTHER RESULTS
Bromoform	3	3 ug/l reported in the distribution system 4/15/81 and 5/13/81 (H_2M).
Bromodichloromethane	49	49 ug/l reported in Well Field No. 1 on 10/6/78 (NYSDH). (Wells were being chlorinated at this time). 24 ug/l reported in the distribution system 8/12/80 (NYSDH). 10.1 ug/l reported in the distribution system 12/17/85 (NYSDH).
Chlorodibromomethane	13	13 ug/l reported in Well Field No. 1 9/26/78 (NYSDH) (Wells were being chlorinated at this time). 10 ug/l reported in the distribution system on 9/26/78, 11/20/78 and 5/13/81 (NYSDH). 11 ug/l reported in Well Field No. 2 1/17/79 and 8/14/80 (NYSDH).
1,2-Dichloroethane	3	3 ug/l reported in distribution system 10/7/80 (H_2M). The presence of this compound was not detected in any other samples based on information available to date.
Vinyl Chloride	20	20 ug/l reported in sample taken from Well 19I on 10/30/85 (CompuChem). Vinyl chloride reported in samples taken 10/30/85 at 6 ug/l, 9.4 ug/l and 1.0 ug/l in Wells 9I, 7I and 3I, respectively (CompuChem). Vinyl chloride at 2 ug/l was reported in the distribution system on 2/11/81, 4/15/81, 5/13/81 and 1 ug/l 8/21/80, 8/25/80, 10/7/80, 12/4/80, 1/9/81, 5/6/81 and 2/9/81 (H_2M). 10 ug/l reported in Well Field No. 1 11/19/80 (H_2M). In 25 samples from Well Field No. 1 collected 7/25/80 - 9/30/82 for analysis by H_2M, 23 samples showed vinyl chloride in the range of 1 ug/l to 10 ug/l and averaged 5 ug/l.
Benzene	130	130 ug/l reported in sample from Well 19S 10/30/85 (CompuChem).
Toluene	110	110 ug/l reported in sample from Well 19S 10/30/85 (CompuChem).
Ethyl Benzene	24	24 ug/l reported in sample from Well 19S 10/30/85 (CompuChem).
Xylenes	1300	1300 ug/l reported in sample from well 19S 10/30/85 (CompuChem).
1,2-Dichloropropane	10	Reported in sample 10/23/79 (H_2M) observation well #6.** Detected in samples from Well Field No. 1 at 2 ug/l in 4 samples and at 1 ug/l in 5 samples in the period 7/25/80 - 11/19/80 (H_2M). Reported in Well Field No. 2 at 1 ug/l 4/17/79 and 8/21/80 (H_2M).

TABLE 1 (continued)

MAXIMUM REPORTED CONTAMINATION IN GROUNDWATER
RI AND PREVIOUS STUDIES (ug/l)

CONTAMINANT	MAXIMUM CONCENTRATION ug/l	OTHER RESULTS
Diethylphthalate	140	140 ug/l reported in a priority pollutant sample taken 10/7/80 (H_2M).
1,1,2,2-Tetrachloroethane	37	Reported in sample taken 1/28/86, Well 17S (CompuChem). One other sample contained 1.3 ug/l 10/30/85 (CompuChem).
bis-(2-ethyhexyl) phthalate	7	Reported in a sample taken 10/30/85, Well 6I (CompuChem).
1,1-Dichloroethylene	25	25 ug/l reported in Test Hole #12 12/27/79 (H_2M).** 1.3 ug/l reported in sample from Well 3S 1/28/86 (CompuChem). One other sample taken 7/30/81 from Well Field No. 1 showed 1,1-DCE at 1 ug/l.
trans-1,3-Dichloropropene	4	Reported in a sample from Well Field No. 1 7/25/80 (H_2M).
Di-n-butylphthalate	5	Reported in sample taken 10/22/85, Well 14I (Compu Chem). 3.0 ug/l and 3.4 ug/l reported in samples taken 10/22/85 from Well 6I and air stripper influent respectively (Compu Chem).
N-nitrosodiphenylamine	2.8	Reported in one sample only 10/22/85, Well 14I (Compu Chem).

TABLE 2

SUMMARY OF RI ANALYTICAL DATA
FOR CRITICAL CONTAMINANTS

MEDIA	PCE	TCE	1,2-DCE
Groundwater*			
Frequency(1)	13/44	10/44	7/44
Maximum Level (ppb)	5600	100	210
Average (ppb)	696	47	107
Groundwater**			
Frequency	12/19	9/19	8/19
Maximum Level (ppb)	3900	67	160
Average (ppb)	668	37	68
Surface Water (Croton River)			
Frequency	3/29	0/29	0/29
Maximum Level	4	--	--
Average	3	--	--
Surface Water (Culvert Discharges)			
Frequency	108/135	101/135	100/135
Maximum Level	1000	136	37
Average	102.1	16.8	5.9
Soils			
Frequency	59/326	41/326	46/326
Maximum	280	46	21
Average	28	5.5	3.3

* CompuChem Results - Sample Round 1. (1985)
**CompuChem Results - Sample Round 2. (1986)
(1) Shows Number of Samples Containing Contaminant Over Total Number of Samples Taken

TABLE 3

SEMI-QUANTITATIVE ANALYSIS
MONITORING WELL SOIL SAMPLES
HNu 301 SCREENING RESULTS (ppb)

DEPTH	WELL 1I			WELL 3I			WELL 6I			WELL 7I			WELL 8I		
	PCE	TCE	1,2-DCE	PCE	TCE	1,2-DCE	PCE	TCE	1,2-DCE	PCE	TCE	1,2-DCE	PCE	TCE	1,2-DCE
0-2															
2-4				1.3		0.1									
4-6								0.3							
6-8						0.5									
8-10															
10-12															
12-14	2.0	1.0	1.0	3.3		18			0.2						
14-16															
16-18				4.9	3.6	2.7									
18-20															
20-22															
22-24	2.0			4.1	1.8	0.7	34	46	4.3						
24-26	2.0	1.0													
26-28	2.0	3.0				0.3	126	10	1.5						
28-30	2.0	1.0													
30-32	2.0	2.0										21			
32-34							242	4.0	1.0				0.3		
34-36												8.0			
36-38	3.0						111	1.3	0.5	7.0	6.0	3.0			
38-40	3.0									39	21	11			
40-42										22	8.0	5.0			
42-44							15	0.6	0.2	20	7.0	5.0			
44-46										3.0					
46-48										1.1					
48-50															
50-52										1.3					
52-54										3.3	0.7	0.3			
54-56										1.1					
56-58															
58-60													0.6	0.2	0.05
60-62															
62-64															
64-66													1.5	0.5	0.1
66-68															
68-70													2.42	.94	0.4
70-72															
72-74															
74-76													19	7.0	2.7
76-78															
78-80													0.7	0.2	0.1

NOTE: ONLY SAMPLES SHOWING VHO CONTAMINATION ARE REPORTED IN THIS TABLE.

TABLE 3 (continued)

SEMI-QUANTITATIVE ANALYSIS
MONITORING WELL SOIL SAMPLES
HNu 301 SCREENING RESULTS (ppb)

DEPTH	WELL 91			WELL 121			WELL 131			WELL 141			WELL 151		
	PCE	TCE	1,2-DCE	PCE	TCE	1,2-DCE	PCE	TCE	1,2-DCE	PCE	TCE	1,2-DCE	PCE	TCE	1,2-DCE
0-2															
2-4															
4-6															
6-8								1.4	0.7						
8-10															
10-12															
12-14								0.5	0.4						
14-16															
16-18															
18-20										0.6					
20-22															
22-24															
24-26	6.0	1.0	0.5												
26-28									0.4						
28-30															
30-32	28	5.0	3.0												
32-34															
34-36	136	21	15	3.0											
36-38				6.0											
38-40															
40-42	96	17	10	2.0											
42-44															
44-46	22	3.0	2.0												
46-48															
48-50															
50-52	2.0	1.0	0.5												
52-54															
54-56															
56-58															0.3
58-60															
60-62															
62-64															
64-66															
66-68															
68-70															
70-72															
72-74															
74-76															
76-78															
78-80															

NOTE: ONLY SAMPLES SHOWING VHO CONTAMINATION ARE REPORTED IN THIS TABLE.

TABLE 3 (continued)

SEMI-QUANTITATIVE ANALYSIS
MONITORING WELL SOIL SAMPLES
HNu 301 SCREENING RESULTS (ppb)

	WELL 161			WELL 171			WELL 191			WELL		
DEPTH	PERC	TCE	1,2-DCE	PERC	TCE	1,2-DCE	PERC	TCE	1,2-DCE	PERC	TCE	1,2-DCE
0-2												
2-4												
4-6												
6-8												
8-10				12.9	8.4	6.3	6.0					
10-12												
12-14				27	8.6	8.5	3.0					
14-16							104	14	6.0			
16-18												
18-20				9.0	3.1	2.7	280	7.0	3.0			
20-22							13					
22-24							66					
24-26	0.5		0.1	4.3	1.2	0.9	18					
26-28							71	0.5	0.2			
28-30												
30-32				16.4	4.0	3.6	53					
32-34	.95	.34	.44									
34-36				3.3	0.7	0.4						
36-38												
38-40												
40-42												
42-44												
44-46												
46-48												
48-50												
50-52												
52-54												
54-56												
56-58												
58-60												
60-62												
62-64												
64-66												
66-68												
68-70												
70-72												
72-74												
74-76												
76-78												
78-80												

NOTE: ONLY SAMPLES SHOWING VHO CONTAMINATION ARE REPORTED IN THIS TABLE.

TABLE 4
CANDIDATE REMEDIAL ACTION TECHNOLOGIES

TECHNOLOGY	APPLICABILITY	REMEDIAL OBJECTIVE
Containment Barriers o Slurry Walls o Vibrated Beam Walls o Grout Curtains o Sheet Piling	May be effective in plume containment if geological conditions and contaminant capatibility warrant	Source Control
Groundwater Pumping o Extraction Wells o Injection Wells	May be effective in plume containment and aquifer cleanup	Source Control
Soil and Waste Excavation and Removal	May be effective in eliminating a source of contamination in plume area	Source Control
Rotary Kiln Incinerator	Could be effective in elimination of contaminants in soil or material excavated in source area	Source Control
Infrared Incineration	Could be effective in elimination of contaminants in soil or material excavated in source area	Source Control
Activated Carbon Treatment	Could be effective in treating water for water supply system, for treatment of groundwater extracted in plume area and for reduction of emissions from air stripping columns	System Control and Source Control
Packed Column Aeration	Effective in treatment of water for water supply system and for treatment of groundwater extracted in plume area	System Control and Source Control

TABLE 4 (CONT'D)
CANDIDATE REMEDIAL ACTION TECHNOLOGIES

TECHNOLOGY	APPLICABILITY	REMEDIAL OBJECTIVE
Drying/Dewatering Bed	Could be effective in handling soils or materials excavated in source area	Source Control
Landfill	If excavation of soils or material is undertaken in plume area, it may be necessary to dispose of materials in approved landfill	Source Control
Alternative Water Supplies Sources o NYC Reservoir o River Intake	May be feasible if institutional and technical constraints are resolved	System Control
Individual Treatment Units	May be feasible if costs and other technical constraints are resolved	System Control

TABLE 5

TECHNOLOGIES SELECTED AS
COMPONENTS OF REMEDIAL ALTERNATIVES

Groundwater Pumping
Extraction Wells
Injection Wells
Soil & Waste Excavation and Removal
Backhoe
Dewatering
Drying or Dewatering Beds
Land Disposal
Secure Landfill
Incineration
Rotary Kiln
Infrared
Treatment of Liquid Waste Streams
Packed Column Aeration
Alternative Water Supplies
Reservoir
River
Individual Treatment Systems

TABLE 6

EVALUATION OF REMEDIAL ACTION ALTERNATIVES
BREWSTER WELL FIELD
SUMMARY

ALTERNATIVE		TECHNICAL CRITERIA				INSTITUTIONAL FACTORS	PUBLIC HEALTH	ENVIRONMENTAL FACTORS	PRESENT WORTH (4)
		PERFORMANCE	RELIABILITY	IMPLEMENTABILITY	SAFETY				
I	No Action	Not Acceptable (1)	Marginal	Good 1	Fair	Not Acceptable	Not Acceptable	Marginal	0 (5)
II	Operation of the existing packed column air stripper	Excellent (2) Marginal (3)	Excellent	Excellent	Good	Excellent (2) Marginal (3)	Excellent	Good	$289,000 (6)
III	Existing Air Stripper, groundwater collection, treatment and injection east of plume	Excellent (2) Good (3)	Good	Good	Good	Good (2) Good (3)	Excellent	Good	$532,000
IV	Existing Air Stripper, groundwater collection, treatment and injection west of plume	Excellent (2) Good (3)	Good	Good	Good	Good (2) Fair (3)	Excellent	Good	$532,000
V	Existing Air Stripper, groundwater collection, treatment and discharge to the existing air stripper at the Well Field	Excellent (2) Fair (3)	Fair	Fair	Fair	Fair	Good	Fair	$558,000
VI	Soil Contamination Alternatives - One of these alternatives is assumed to be part of any remedial action plan, if a contaminated soil source is identified. These costs are not included in the costs stated above.								
	Off-Site Disposal								$294,106
	On-Site Rotary Kiln Incinerator								$990,375
	On-Site Infrared Incinerator								$110,000

(1) Not acceptable from regulatory standpoint
(2) In terms of system objectives
(3) In terms of source control objectives
(4) Includes present worth of O & M
(5) The present worth or cost of this alternative is zero in the comparative analysis framework established for the Feasibility Study. In actuality, the option for No Action does not exist because a treatment system (existing packed column air stripper) has already been installed at the Site.
(6) For the comparative analysis framework established for the Feasibility Study, the cost of this alternative was developed assuming the packed column does not presently exist. In actuality, the capital costs of the alternative have already been expended.

APPENDICES

Appendix A

Tetrachloroethylene

Chemistry and Metabolism

Tetrachloroethylene (perchloroethylene) is a halogenated aliphatic hydrocarbon of molecular weight 165.83.

Oral absorption data is scanty and qualitative. An early study noted that intestinal absorption in dogs was facilitated by fats and oils. In humans, pulmonary absorption is rapid and inhalation is the most common exposure route. While metabolism of perchlorethylene is fairly slow in humans, metabolic products, such as the reactive PCE epoxide, have been shown to be both carcinogenic and mutagenic, embodying much of the risk potential of the parent compound (EPA, 1986). Low percentages of doses are reported as being excreted as metabolites, principally as trichloroacetic acid.

Toxicity

Tetrachloroethylene is considered a probable human carcinogen. A cohort study of deceased laundry and dry-cleaning workers' medical histories revealed excessive lung, cervical, and skin cancers, and a slight excess of leukemias and liver cancers, but the subjects' exposure to trichloroethylene and carbon tetrachloride in addition to perchloroethylene precluded definitive identification of the causal role of perchloroethylene.

rpt519.857

PCE's carcinogenic potential resides primarily in its biologically reactive metabolites such as the PCE epoxide intermediate (EPA, 1986). A 1977 ingestion study using rats and mice reported decreased survival rates in both species and highly significant increases in hepatocellular carcinomas in the mice. (No increase was observed for rats).

A 1985 (draft) National Toxicology Program lifetime inhalation bioassay with rats and mice demonstrated that perchloroethylene induced carcinogenic effects in rats and mice. Although EPA acknowledged that certain aspects of the conduct of the bioassay might invalidate a reported marginally statistically significant leukemia incidence in one strain of male rats, the two sets of animal studies were considered to provide evidence justifying alteration of the previously developed carcinogenic risk factor in March, 1986.

The 1985 NTP study data were used to estimate unit risk of PCE via inhalation in three ranges. The first range uses metabolized dose derived from a single exposure balance study and the second and third ranges are calculated on the basis of metabolized doses derived from a physiologically-based pharmacokinetic (PB-PK) model. Until uncertainties regarding PB-PK model parameters are resolved, EPA recommends using the first range, which yields a revised upper-bound estimate of incremental cancer risk (due to lifetime exposure of 1 $\mu g/m^3$ of PCE in air) ranging from 2.9×10^{-7} to 9.5×10^{-7}.

rpt519.857

(This is applicable only to low level exposures where a linear relationship exists between ambient concentration and metabolized dose.)

In September 1985, EPA published a carcinogenic potency factor for humans of $5.10 \times 10^{-2} (mg/kg/day)^{-1}$. ACGIH (1983) recommended a TWA-TLV of 50 ppm and a STEL of 200 ppp, while OSHA has implemented a permissable exposure level (8-hour TWA) of 100 ppm (CRF, 1981).

In humans, chronic inhalation exposure to a range of perchlorethylene concentrations have been reported to lead to respiratory irritation, nausea and other intestinal effects, insomnia, headache, liver cirrhosis, hepatitis, and nephritis, although dose levels were not quantified.

Effects of subchronic inhalation exposure to perchlorethylene in experimental animals include a number of histopathological and organ function alterations. For example, rats showed EEG changes and cerebral cortical cell changes, liver and spleen congestion and kidney injury. Mice demonstrated alterations in muscle response while rabbits showed pathomorphological and organ function abnormalities. Guinea pigs are unusually susceptible to perchlorethylene, according to evidence from studies which found pathologic changes in both liver and kidney at doses lower or comparable to those which induced no evidence of damage in monkeys, rabbits or rats.

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Little information exists regarding chronic toxicity due to perchlorethylene exposure. In a 1977 NCI oral carcinogenicity bioassay with mice and rats, toxic nephropathy was observed at all dose levels in both sexes of both species, leading to establishment of LOAEL's for toxic nephropathy of 300 mg/kg/day for mice and 471 mg/kg/day for rats. Unspecified reversible liver damage was reported.

Other aspects of tetrachloroethylene toxicology include teratogenicity and potential interaction with other toxicants. Teratogenic effects were found in two species of rodents when 300 ppm was administered via inhalation for 7 hours per day during a portion of the gestation period.

Tetrachloroethylene toxicity is believed to be affected by compounds that alter microsomal enzyme function, because of its metabolism by mixed function oxidases. Synergistic effects have been demonstrated with Arochlor pretreatment, with alcohol, and with benzene.

In the few reports available, perchlorethylene has elicited mixed responses in mutagenicity tests. Results were positive in tests with two Salmonella assays, but were negative with Escherichia coli and with bone marrow cells in intraperitoneally injected mice.

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Trichloroethylene

Chemistry and Metabolism

Trichloroethylene (TCE) is a halogenated aliphatic hydrocarbon of molecular weight 131.5.

The metabolism of trichloroethylene has been reviewed by numerous authors. Although oral absorption rates are not available for humans, rats were found to absorb 80-100% of ingested TCE. Human absorption of inhaled TCE is rapid, leading to equilibrium body levels in roughly two hours.

Major metabolites of TCE are trichloroacetic (TCA) acid and trichloroethanol. Other minor metabolites noted in the literature include chloroform and monochloroacetic acid. Of these, trichloroethanol is excreted in the highest volumes and has itself been found to have a pronounced depressing effect on the central nervous system. Given the long biological half-life of TCE, cumulative effects of the parent compound and the metabolite may be very significant. Ikeda and others (1972) found that workers exposed to 100 ppm TCE excreted only one third of the dose as metabolites during the work day, while other investigators have found gradually increased metabolite excretion suggestive of bioaccumulation of metabolites.

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Toxicity

The principal toxic effect of concern with TCE is carcinogenicity. TCE was shown to be carcinogenic in mice via inhalation exposure in three sets of reported results, although two of these studies were faulty. As of the publication date of EPA's health assessment document on TCE, inhalation cancer bioassays had not yielded positive results with rats or hamsters. In two oral studies conducted by NTP and NCI, on the other hand, an increased incidence of hepatocellar carcinoma was found in mice. Carcinogenic potency factors of $6 \times 10^{-3}(mg/kg/day)^{-1}$ for inhalation and 1.9×10^{-2} $(mg/kg/day)^{-1}$ based on oral ingestion were computed by Fukada et. al. (1983) and EPA respectively.

Although human epidemiological studies have failed to demonstrate a relationship between increased cancer risk and TCE exposure, EPA has applied proposed CAG criteria in evaluating overall animal evidence, and has classified TCE as a Group B2-Probable Human Carcinogen. Human overexposure to TCE produces depression of the central nervous system. Mental confusion, incoordination and insomnia have been reported. The ACGIH (1983) recommended a TWA-TLV of 50 ppm (270 mg/m^3) and a STEL of 150 ppm (560 mg/m^3) for TCE.

TCE has been found to cause increased mutagenesis in several tests using Salmonella typhinaurium and Saccharomyced cerevisiae after metabolic activation and in a mouse spot test conducted by Fahrig (1977).

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Toxic effects of TCE have been demonstrated in humans and experimental animals. Results of subchronic oral exposure in animals include increased liver weight ratio and elevated urine ketone and protein levels in male rats at moderate doses and decreased body weights, increased liver and kidney weights, and elevated urine ketone and protein levels in both sexes of rats at high doses. In subchronic inhalation studies with rats and guinea pigs, guinea pigs were found to be more sensitive than rats, demonstrating decreased body weight at half the dosages inducing similar effects in rats.

Acute responses of animals to TCE reported include increased liver and kidney weight and cell changes in the cerebellum. TCE fatalities investigated have been reported to result from cardiac arrhythmia caused by the potentiation of endogenous epinephrene by TCE.

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1,2-Dichloroethylene

This toxicity profile will present a summary of available toxicological information on both isomers of dichloroethylene, trans-1,2-dichloroethylene and cis-1,2-dichloroethylene. Very little empirical data exists on either of the isomers. Molecular weight is 96.95.

Chemistry and Metabolism

Although pertinent data regarding oral absorption of DCEs is unavailable, EPA (1980a) estimated that "virtually 100% of ingested DCE may be absorbed systemically," based on experimental studies by Daniel (1963) and Monster (1976) using trichloroethylene.

Data regarding absorption via inhalation are similarly unavailable, but the Daniel and Monster studies formed the basis for an EPA estimate of 35 to 50 percent absorption (EPA, 1980a).

DCE metabolism has not been investigated.

Toxicity

Very little experimental investigation has addressed DCE's toxicity to laboratory animals or humans. Similarly, both isomers of 1,2-DCE are designated as Group D-Unclassified by EPA's Cancer Assessment Group.

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Limited data on subchronic exposure data on the trans isomer were found. An oral study with a mixture of isomers by Springer (1965) and an inhalation study by Torkelson (unpublished, 1965) reported no adverse effects. Freundt et al. (1977) found progressive damage to the lungs and fatty changes in the livers of Wistar rats administered t-1,2,-DCE via inhalation.

Cis-1,2-DCE administered to rats by Jenkins et al. (1972) in a single oral dose resulted in increased levels of a series of hepatic enzymes indicative of hepatotoxicity. The authors suggested that the cis isomer was less hepatotoxic than 1,1-DCE, but more hepatotoxic than the trans isomer.

Freundt et al. (1977) exposed rats via inhalation to 200 ppm cis isomer, finding inhibition of the mixed function oxidase system as measured by several parameters, and suggested that the cis isomer was a more potent inhibitor than the trans isomer in a later study (Freundt and Macholz, 1978). Similarly, EPA (1984) postulates that the cis isomer might be expected to effect the toxicity of other compounds metabolized via the mixed function oxidase system, due to the effects of cis-1,2-DCE on cytochrome P-450. Subsequent research into toxic actions of metabolites (Costa and Ivanetich, 1982) indicates that the cis isomer is probably nephrotoxic by analogy to 1,1-DCE (U.S. EPA, 1980b).

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Data on acute toxic effects of the DCE isomers are extremely limited. The Merck Index (1983) reports research indicating animal liver and kidney injury and an LD50 (isomer unspecified) in rats of 770 mg/kg orally (RTECS, v.1, R.J. Lewis and R.L. Tatken, Eds., 1979), while Sax (1983) reports lethal doses of 65,000 mg/m^3/2 hrs and 20,000 mg/m^3/6 hrs administered to mice and cats respectively. Sax reports a low toxic threshold via oral routes, stating that high concentrations cause irritation and narcosis (species unspecified).

No data is available on the teratogenicity or carcinogenicity of either DCE isomer. The ACGIH (1980, 1983) established a TLV for both isomers of 200 ppm (approximately 1000 mg/m^3) based on Torkelsen's unpublished 1965 study of sub-chronic inhalation effects.

Research on the mutagenicity of the DCE isomers has been limited and has produced mixed results. Greion et al. (1975) found both cis and trans isomers to be nonmutagenic to E.coli K12. Cerna and Kypenova (1977) tested both isomers with Salmonella tester strains using the spot test. In the same study, the trans isomer failed to induce chromosomal aberrations in mouse bone marrow cells following injections, but the cis isomer did produce dose-dependent increases in mutations using the host-media bioassay. The cis isomer also induced chromosomal aberrations in the bone marrow cells of mice given repeated injections. The cis isomer failed to induce mutation or gene conversion in Saccharomyces cerevesiae (Galli et al., 1982).

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APPENDIX B
SUMMARY
ESTIMATED COSTS OF REMEDIAL ALTERNATIVES

Alternative	Capital Costs ($)	O&M Costs ($/yr)	Present Worth O&M Costs ($)	Present Worth Total Costs ($)
II - Existing Stripper	138,500(D)	9,870(E)	131,607(A)	288,691(B)
III/IV - Existing Stripper with Plume Treatment and Injection (East or West)	302,412(D)	37,338(E)	229,403(C)	531,815
V - Existing Stripper, Plume Treatment and Discharge to Well Field	293,067(D)	43,124(E)	264,953(C)	558,020

Notes: (A) PW based on 25 years at 10%.

(B) Includes PW of replacement after 20 years.

(C) PW based on 10 years at 10%.

(D) Includes 138,500 capital of existing Stripper which is built & paid for.

(E) Includes 9,870 current annual O&M of existing stripper.

Appendix C

Estimated Costs - Selected Alternative

ALTERNATIVE III - Existing Air Stripper, Groundwater Collection, Treatment and Injection East of the Plume

For the alternatives with remedial action south of the River the computer simulations indicate the contamination in the Well Field could reach 5 ppb in 10 years. Accordingly, the present worth calculations, both for the on-Site stripping column and the off-Site remedial system are assumed to have a useful life of 10 years for the economic evaluation.

A. Capital Costs - Off-Site Stripper

1. Equipment		$ 28,000	
2. Labor		32,100	
3. Other		11,000	
	Subtotal	$ 71,100	
4. Engineering (15%)		10,665	
5. Contingencies (15%)		10,665	
	CAPITAL COST	$ 92,410	$ 92,410

B. Capital Costs - Wells

1. 4 Extraction Wells		$ 28,553	
2. 6 Passive Injection Wells		26,449	
	Subtotal	$ 55,002	
3. Engineering (15%)		$ 8,250	
4. Contingencies (15%)		8,250	
	CAPITAL COST	$ 71,502	$ 71,502

*Total Capital Cost of GW Treatment.... $163,912

C. O & M Costs - Off Site Stripper

1. Power		$ 4,600	
2. Materials		$ 1,400	
3. Labor		$ 9,600	
	TOTAL O & M	$ 15,600	$ 15,600

D. O & M Costs - Wells

1. Extraction Wells		$ 6,568	
2. Passive Injection Wells		$ 5,300	
	TOTAL O & M	$ 11,868	$ 11,868

*Total O&M Cost of GW Treatment..... $ 27,468

E. Capital Costs - Existing Stripper

1.	Column shell, internals and packing	$ 40,775
2.	Air blowers	4,620
3.	Air Well/Foundation for building	12,875
4.	Piping Valves and Appurtenances	7,500
5.	Air Duct work and Appurtenances	7,260
6.	Instrumentation	1,320
7.	Electrical	14,700
8.	Building and Site Work	21,800
9.	Engineering (15%)	$ 16,630
10.	Contingency (10% in this case because actual costs figures are available)	$ 11,080
	TOTAL CAPITAL COST	$138,500

*Total Capital Cost of Existing Stripper...$138,500(1)

F. Operation and Maintenance (Annual)-

1.	Power	$ 3,430
2.	Materials	200
3.	Labor	6,240
	TOTAL O&M	$ 9,870

*Total O&M Cost of Existing Stripper.... $ 9,870 (0)

Notes:

1. Existing Stripper is already built & paid for.
2. O&M of existing stripper paid by Village.

RESPONSIVENESS SUMMARY

Brewster Responsiveness Summary
To Comments At Public Meeting 8/21/86

C- One commenter asked if it was possible that the contamination existed before 1978 and how the contamination was discovered in 1978.

R- It is possible that the contamination existed in the soil and groundwater before 1978 but no contamination was found in the water supply until 1978 when it was discovered in routine sampling.

C- The same commenter asked why it took from 1978 to 1985 to do the Superfund study.

R- Since the contamination was first discovered in 1978 several measures were taken to protect the public health. These measures included the investigation and use of alternate water supplies, public health advisories to boil water when it was necessary, and ultimately the construction of the packed column air stripping system that is now successfully being utilized. Superfund legislation was not enacted until 1980 and it was not until 1983 that Brewster was added to the National Priorities List of Superfund sites.

C- One commenter asked what soil contamination has been found.

R- Semi-quantitative soil screening was conducted during soil boring operations of the Remedial Investigation and the results are included in the Remedial Investigation report. Heavy contaminant concentrations have been found at depths of 30 feet and more at some locations.

C- Another commenter asked whether PCE was used in other than dry cleaning operations.

R- PCE is also used for metal degreasing.

C- One commenter asked where other contaminants such as benzene and xylene may have come from.

R- Benzene and xylene are found in gasoline which may have come from a spill.

C- Another commenter asked what the source of the vinyl chloride found might have been.

R- Vinyl chloride may have been generated as the result of the biological degradation of PCE.

C- One commenter asked how it is possible to pinpoint the location of the contaminant source or sources.

R- Historical studies of the area and business inventories could help to identify possible sources. Site investigation, sampling and monitoring would help to confirm the location of the source.

C- One commenter asked whether the Alternate 2 packed column would continue to work as the highly concentrated contaminant plume is drawn toward the well field.

R- Any contamination from the plume will be diluted with surrounding groundwater as it is drawn toward the well field. And by holding on to contaminants the soil itself mitigates contaminant movement to a degree. Additionally, the packed tower has flexibility and can react to higher concentrations; although we believe conditions have reached steady state.

C- Two commenters asked if the system was reviewed periodically and how often samples were taken.

R- Samples are taken and reviewed monthly as an indicator of the system's operation. The historical trend, against which the samples are reviewed is a good indication of concentration levels and abrupt system adjustments and more frequent sampling aren't considered necessary.

C- One commenter asked for clarification of the remediation proposed south of the river and its cost.

R- The remediation proposed south of the river consists of groundwater extraction via wells, pack column treatment, and reinjection via wells. This would enable clean-up of TCE to proposed Federal standards (5ppb) at both the well field and the area south of the river in 10 years. Without this remediation clean-up would take 25-30 years at the well field and 30-35 years south of the river. The cost of this remediation would be the costs of Alternate 3 minus Alternate 2 or $243,000.

C- One commenter wanted to know when a final decision would be made.

R- A final decision will be made after the public comment period ends on September 8, 1986 via a Record of Decision which will be issued by EPA.

C- One commenter asked if the Brewster contamination could be affecting other water supply systems.

R- There is no evidence of this and this is not suspected. The Putnam County Department of Health would advise affected communities if there were.

C- One commenter asked if there were any discharge to the river and concern was expressed over fish uptake.

R- Very low concentrations (4ppb) were recorded at several points along the river and continued monitoring is recommended at those locations. The river itself though, has a natural stripping action. At these low levels fish uptake is not a concern.

C- One commenter asked if any monitoring was done in the vicinity of the Bottge septage site.

R- This storage area rests on fill directly over bedrock and any contamination from this site would affect the bedrock aquifer. however, the Brewster contamination exists primarily in the unconsolidated aquifer and apparently is unrelated to the site. The nature and quantity of substances used at this site also make it an unlikely source. Therefore, no monitoring was done.

C- One commenter asked what the likely sources of gasoline were.

R- The most likely source was a spill.

C- One commenter asked if VHO's could be assimilated other than by direct ingestion.

R- VHO's can also be assimilated by inhalation and dermal contact.

C- Another commenter wanted to know what levels can now be found in the village's drinking water.

R- The most recent sampling showed less than detectable levels of VHOs (less than 1ppb).

C- Another commenter asked how long it would take for any contamination to travel from Alben Cleaners to reach the well field.

R- Groundwater would take approximately 6 years to travel this route. Contaminant travel would take somewhat longer because of the mitigating effects of the soil.

C- One commenter wanted to know if it was possible to estimate the quantity of contaminants in the groundwater.

R- Not accurately, but we could estimate the amount which has been stripped out to date, based on flow and removal percentages.

C- Another commenter asked if anything was being done to avoid this type of contamination in the future.

R- At the Federal level legislation and regulation such as the Resource Conservation and Recovery Act requires hazardous substances to be monitored from cradle to grave. Various other Federal and State programs require permits to transport, store and dispose of these substances.

C- Another commenter asked if there were going to be any more public meetings.

R- No further public meetings will be held on the first operable unit (consisting of continued operation of the existing on-Site air stripper and construction of a groundwater management system of extraction wells, treatment of extract groundwater, and reinjection, to contain the plume of contamination and restore groundwater quality south of the River). However written comments can be submitted until September 8, 1986. In the future an additional public meeting will be held on the second operable unit which will address source control measures.

C- A final commenter asked if an endangerment assessment was done.

R- A risk assessment was conducted and the results are presented in the Feasibility Study report.